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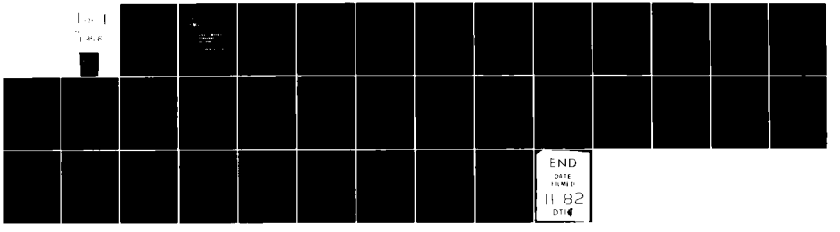

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Design criteria for Unaccompanied Personnel Housing are presented for use by experienced architects, interior designers and engineers. This manual provides general design guidance for Unaccompanied Enlisted Quarters, Unaccompanied Officer Quarters, and Enlisted Personnel Dining Facilities for Navy and Marine Corps personnel. Modernization programs for existing facilities are also covered.

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AUGUST 1981

UNACCOMPANIED PERSONNEL HOUSING

DESIGN MANUAL 36.1

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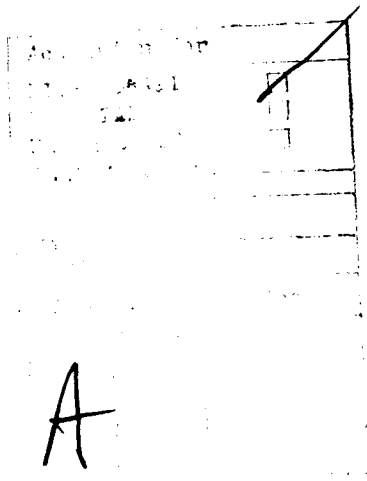
ABSTRACT

Design criteria for Unaccompanied Personnel Housing are presented for use by experienced architects, interior designers, and engineers. This manual provides general design guidance for Unaccompanied Enlisted Quarters, Unaccompanied Officer Quarters, and Enlisted Personnel Dining Facilities for Navy and Marine Corps personnel. Modernization programs for existing facilities are also covered.



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FOREWORD

This design manual is one of a series developed from an evaluation of facilities in the shore establishment, from surveys of the availability of new materials and construction methods, and from selection of the best design practices of the Naval Facilities Engineering Command, other Government agencies, and the private sector. This manual uses, to the maximum extent feasible, national professional society, association, and institute standards in accordance with NAVFACENGCOM policy. Deviations from these criteria should not be made without prior approval of NAVFACENGCOM Headquarters (Code 04).

Design cannot remain static any more than can the naval functions it serves or the technologies it uses. Accordingly, recommendations for improvement are encouraged from within the Navy and from the private sector and should be furnished to NAVFACENGCOM Headquarters, Code 04. As the design manuals are revised, they are being restructured. A chapter or a combination of chapters will be issued as a separate design manual for ready reference to specific criteria.

This publication is certified as an official publication of the Naval Facilities Engineering Command, and has been reviewed and approved in accordance with SECNAVINST 5600.16A.

W. M. Zobel
Rear Admiral, CEC, U. S. Navy
Commander
Naval Facilities Engineering Command

UNACCOMPANIED PERSONNEL HOUSING

DM No.	Superseded Chapters in Basic DM-36	Title
36.1	New material	Unaccompanied Personnel Housing
36.2	1	Unaccompanied Enlisted Quarters
36.3	3	Unaccompanied Officer Quarters
36.4	2	Enlisted Personnel Dining Facilities

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UNACCOMPANIED PERSONNEL HOUSING

Section 1. INTRODUCTION

1. PURPOSE. This manual provides general design guidance relating to Unaccompanied Personnel Housing. Specific programming information for the three building types is contained in NAVFAC DM-36.2, Unaccompanied Enlisted Quarters; 36.3, Unaccompanied Officer Quarters; and 36.4, Enlisted Personnel Dining Facilities. The manuals are intended to assist designers in creating the highest quality living and dining facilities for unaccompanied personnel within statutory cost limitations and in conformance with DOD criteri It is intended that modernization projects up-date existing facilities to me as nearly as practicable the established criteria within economic constrain

2. CANCELLATION. This publication in conjunction with 36.2, 36.3, and 36.4 cancels and supersedes Troop Housing NAVFAC DM-36 of Feb 1968 in its entirety including change 1, dated May 1968.

3. RELATED CRITERIA.

Subject	Source
DOD Construction Criteria Manual	DOD 4270.1-M
Facility Planning Factor Criteria for Navy and Marine Corps Shore Installations	NAVFAC P-80, Vol. 2
Definitive Designs for Naval Shore Facilities	NAVFAC P-272
Color for Naval Shore Facilities	NAVFAC P-309
Interior Design	NAVFACINST 11012.120
Planting Design	NAVFAC P-904
Energy Conservation in New and Rehabilitated Buildings by Computer Simulation of Building Energy Consuming Systems	NAVFACINST 4100.7
Design Criteria Guidance for Energy Conservation	NAVFACINST 4100.5A
Identification of Retrofit Projects for Buildings	DOE/CS-0133

Subject	Source
Impact Noise Control in Multifamily Dwellings	FHA 750
Contracting Manual	NAVFAC P-68
MILCON Statutory Cost Limitations On Bachelor Housing	NAVFACINST 11013.10G
Seismic Design for Buildings	NAVFAC P-355
Engineering Weather Data	NAVFAC P-89
American Society of Heating, Refrigerating, and Air-Conditioning Engineers	ASHRAE
National Fire Protection Association	NFPA Code Series

4. DESIGN PHILOSOPHY.

a. Purpose. The objective of the design criteria and concept guidance contained in this manual is to assist experienced planners and designers in creating the best possible living environments within allowable space and cost limitations. Imaginative approaches should be encouraged to create the highest quality of design, livability, and energy consumption effectiveness. Definitive or standard designs for Unaccompanied Enlisted Quarters an' Unaccompanied Officer Quarters must be adhered to for the basic sleeping modules; however, the core and administrative areas shall be designed to meet the program requirements of the specific project.

b. Functional Requirements. Unaccompanied Personnel Housing facilities shall be designed to provide and promote individual privacy, personal identity, human scale, retention of personnel, opportunities for fellowship, a sense of pride and spirit, and an interest in caring for the facilities. Operational design considerations should include administrative control, flexibility in facility usage, acoustical control, proper storage, temperature control, security, ease of maintenance, and efficiency of operation.

c. Completeness. It is the objective of each new or modernization project for Unaccompanied Personnel Housing to provide facilities that are complete and responsive to the functional requirements of the activity.

d. Durability. The design solutions shall result in durable facilities with reasonable and appropriate maintenance and operating costs throughout the life of the building. Designers are encouraged to visit similar facilities, talk with building managers and users, and when available, review post occupancy reports for other like projects in order to avoid design errors that adversely affect operation and maintenance.

e. Economic Studies. Economic studies shall be undertaken to determine the design that will result in the most efficient and effective facility at the most economical cost and least adverse impact to the environment. Energy conservation methods and techniques as promulgated in DOE/CS-0133, Identification of Retrofit Projects for Buildings; NAVFACINST 4100.5A, Design Criteria Guidance for Energy Conservation; and a computer study as required by NAVFACINST 4100.7, Energy Conservation in New and Rehabilitated Buildings by Computer Simulation of Building Energy Consuming Systems shall be utilized to achieve energy conservation. Studies shall include consideration of site orientation; architectural features such as building configuration, column spacing, and story heights; structural systems; exterior and interior finishes; plumbing, electrical, heating, and air-conditioning systems; site utilities; and site design. Studies shall also include life cycle facility cost analysis, consideration of initial construction cost, and operation and maintenance budgets over the design life of the facilities. Consideration must also be given to the amount of fuel on a Btu basis required to supply the energy needs to satisfy the cooling and heating loads of the facility. For projects in excess of $300,000, design studies shall be prepared in order to identify the alternatives and the basis for selection of the desired solutions.

f. Regulatory Authorities. Facilities shall be designed to meet all environmental requirements at Federal, State, and local levels.

g. Materials. Consideration shall be given to the use of suitable local materials and construction methods. New materials and techniques for construction shall only be used where it can be shown in actual practice that there is either an economic or functional advantage at no increase in cost over conventional systems. Wherever possible, stock or standard materials, fixtures, and equipment shall be used.

Section 2. COST LIMITATIONS

1. BUDGET COST ESTIMATES. The statutory 5-foot line budget limitation applies to all Unaccompanied Personnel Housing to be constructed at locations in the U.S. (including Alaska and Hawaii) having a geographical cost index of 1.0, regardless of building size. For other locations, the limitation is multiplied by the appropriate geographical cost index (to be found in Section 5 of the current DOD Military Construction Cost Review Guide 4270.1CG). After such modification, the statutory 5-foot line budget limitation cannot be exceeded without the approval of a waiver, as described in NAVFAC P-68, Contracting Manual. The 5-foot line portion of the budget cost estimate should be such that, when divided by the gross building floor area, the resulting figure is equal to or less than the DOD proposed statutory 5-foot line budget limitation (cited by separate correspondence), adjusted by the appropriate geographical cost index.

2. GROSS AREA COMPUTATIONS. The gross building floor area shall include the total area of all floors measured to the effective outside dimensions of the building including mezzanines, basements, and penthouses. One-half area shall

be included for uncovered loading platforms, and covered but not enclosed passageways, porches, balconies, and stairs. Enclosed stairways shall be figured as full area at each floor. Covered ground level or depressed loading platforms shall be figured at full area. Exterior uncovered stairs, stoops, paved terraces, and all enclosed space having an average ceiling height of less than 7 feet shall be excluded. Gross area allowances for unaccompanied housing does not include the required mechanical equipment space unless otherwise noted. Enclosed mechanical equipment rooms and space, however, must be included in gross building area at full value when figuring square foot cost.

3. DETERMINATION OF BASIC BUILDING COST. The 5-foot line portion of the engineering cost estimate shall include costs as follows.

a. Items Considered Part of the Basic Building Cost. The 5-foot line portion of the engineering cost estimate shall include the following items.

(1) Fire sprinkler system (if required), alarm systems, and other built-in electrical systems.

(2) Venetian blinds.

(3) Individual wardrobes, storage walls, and all partitions.

(4) All mechanical equipment, including mechanical ventilation, evaporative cooling, and air-conditioning.

(5) Double glazing and all other energy-conserving provisions warranted by life-cycle analysis.

b. Items Considered Separate From Basic Building Cost. The 5-foot line portion of the engineering cost estimate shall not include the following items.

(1) Seismic construction additional costs.

(2) Special foundations such as piles.

(3) Fallout shelter areas when authorized.

(4) Sound attenuation additional costs.

(5) All work outside of the 5-foot line.

(6) Chests for wardrobes.

(7) Any other cost that would be considered unique or unusual to the facility and therefore not typical to other Unaccompanied Personnel Housing or dining facilities.

4. CALCULATION OF 5-FOOT LINE PORTION OF THE BUDGET COST ESTIMATE. For estimating purposes prior to bid opening, the 5-foot line portion of the budget cost estimate is calculated as follows.

$$B = E(1.00 + C)\ (1.00 + SIOH)$$

Where B = 5-foot line portion of budget cost estimate.
E = 5-foot line portion of engineering cost estimate (or contract cost estimate), consisting of the current contractor costs projected to the anticipated time of bidding.
C = Contingency factor expressed as a decimal (2 percent unless directed otherwise by NAVFACENGCOM).
SIOH = supervision, inspection, and overhead percentage expressed as a decimal (5.5 percent unless directed otherwise by NAVFACENGCOM).

5. FINAL DETERMINATION OF 5-FOOT LINE PORTION OF THE BUDGET COST ESTIMATE. After bid opening, determination of 5-foot line cost and compliance with statutory limitations shall be determined in accordance with NAVFACINST 11013.10G, MILCON Statutory Cost Limitations on Bachelor Housing.

6. MODERNIZATION PROJECT COST LIMITATIONS. For modernization projects the square foot cost shall not exceed the statutory limitation for new construction.

Section 3. SITE

1. DESIGN CONSIDERATIONS. In planning and designing Unaccompanied Personnel Housing and dining facilities, site considerations shall include the following.

a. Building Orientation. Site orientation shall minimize surface exposure to the afternoon sun and minimize solar loading of fenestration in both the morning and afternoon, especially for air-conditioned buildings. The design shall maximize exposure to prevailing summer breezes. In addition to solar considerations, orientation shall also be responsive to natural topography, functional site relationships, access, and views.

b. Topography. Grading shall be minimized and the natural character of the site preserved. Ground shapes, rock outcrops, water, ledges, and other natural features shall be preserved to the greatest extent possible to maintain site character.

c. Parking and Service. Parking shall be coordinated with underground utilities. The extremes of a profusion of small lots or excessively large lots shall be avoided. Tree islands or natural features may be used to relieve the massive character of large lots. Parking shall be oriented to allow for ease of access to the main entrance. The service entrance shall be properly screened and appropriately located so as to avoid excessively long access drives. Reference shall be made to DOD 4270.1-M, Construction Criteria Manual, NAVFAC DM-5 series, Civil Engineering, and NAVFAC P-272, Definitive Designs for Naval Shore Facilities, Part 2, Drawing No. 1294412.

d. Sidewalks. Location of walkways shall be determined in accordance with the efficient flow of exterior pedestrian traffic. Excessive walks shall be

avoided and grades shall follow natural topography where feasible to avoid steps. Where steps are used, design criteria contained in NAVFAC DM-5 series shall be used.

e. Landscaping. Planting should enhance exteriors and integrate the buildings with adjacent open areas, establish and define land use, give scale and character to the buildings and their surroundings, provide privacy, reduce air-conditioning loads, provide shade, wind breaks or snow breaks, screen out views of less desirable features, and reduce noise, dust, and soil erosion. Planting design should be simple, functional, economical to maintain, and compatible with adjacent surroundings. Use species proven hardy and tolerant of local site conditions, and coordinate planting so as not to conflict with utilities. Minimize planting obstacles to snow removal. NAVFAC P-904, Planting Design, shall be referenced for further guidance regarding landscaping.

f. Site Utilities. Major considerations should include: (1) utility easements or right-of-way; (2) location, size, and elevations of sanitary sewers, storm drains, or open drainage, drain inlets and manholes; (3) location, elevation, and size of water supply, gas heat transmission mains, and underground electrical service; (4) location and size of overhead electric service, street lighting, and telephone lines including pole and manhole locations; and (5) location of fire alarm call boxes.

g. Civil Engineering. Site engineering shall take into account the following considerations:

(1) Development of economical building sites.

(2) Disposal of surface water.

(3) Preservation of the natural character of the terrain by minimum disturbance of existing ground forms and vegetation cover.

(4) Minimum earth moving with reasonable balance of cut and fill.

(5) Avoidance of earth banks that may require costly measures for erosion control.

(6) A minimum number of steps to entrances.

(7) Establishing satisfactory grade levels around buildings and saving existing trees.

h. Solar Energy. Siting shall also take into account orientation for solar heating and possible retrofit for solar heating.

Section 4. ARCHITECTURAL

1. GENERAL. Careful attention should be given to architectural detail and the careful integration of all building systems. The emphasis shall be on simple, straightforward solutions to both interior and exterior design details rather than elaborate or extraneous architectural embellishments. It should be recognized that good design does not imply added expense, but in fact can mean economical and functional results.

2. MATERIALS AND CONSTRUCTION. Local materials and construction practices shall be used to the greatest extent possible within the limits of established criteria. Buildings shall be designed to be residential in character and thus avoid an institutional appearance. Exterior building finishes shall harmonize with surrounding architecture provided that statutory cost limitations are met and habitability features maintained. Interior finishes shall be economical, durable, and of low maintenance.

a. Windows.

(1) Size. For emergency rescue purposes, each sleeping room window in Unaccompanied Personnel Housing, where rooms do not have direct exit doors to the exterior, shall:

(a) Be operable from the inside without the aid of tools;

(b) Have a minimum clear opening of 22 inches in the least dimension;

(c) Be not less than 5 square feet in area;

(d) Have a sill height not more than 4 feet above the floor;

(e) Have half of the glass area to be opened.

Window glass area shall also be consistent with DOE/CS-0133.

(2) Glazing. Glazed openings that are so located as to be subject to accidental human impact, such as sidelights adjacent to entrance doors that extend to the floor, glazed panels closer than 18 inches to the floor, sliding glass door units (both sliding and fixed sections), and fully glazed doors, shall be glazed with fully tempered glass, wire glass, laminated safety glass, or acrylic sheet, as appropriate. Designs shall follow the criteria contained in the Safety Standard for Architectural Glazing Materials (16 CFR Part 1201) as issued by the U.S. Consumer Product Safety Commission on January 6, 1977 and as effective on July 6, 1977.

(3) Storm Sash or Insulating Glass. The provision of storm sash or insulating glass is mandatory in locations where the winter design temperature is 15 degrees F dry bulb or less. Exceptions to this policy may be granted by NAVFACENGCOM.

(4) Screens. Insect screens shall be provided for all operable windows in habitable rooms.

(5) Window Orientation. All buildings heated to a minimum of 65 degrees F and located in climates having more than 4,000 heating degree days annually shall be designed with a minimum (not more than 10 percent of the wall area) of glazed openings facing north and/or in the direction of the prevailing winter winds. When windows must be used in these locations, the provision of insulating glass shall also be considered. For example, assuming a prevailing west wind, not over 10 percent of the north wall may be glazed and not over 10 percent of the west. Orientation should consider the possibility of economical application of architectural shading of windows.

b. Doors.

(1) Size. Standard sizes suited to functional and fire safety requirements shall be used.

(2) Screen Doors. Where screen doors are required, use heavy duty type hung to swing in the direction of egress and, where possible, located in a protected vestibule.

(3) Security. Proper consideration shall be given to security, including proper hardware and the use of vision panels or door safety viewers.

c. Noise.

(1) Unaccompanied Personnel Housing shall not be sited in Composite Noise Rating (CNR) Zone 3.

(2) Unaccompanied Personnel Housing sited in CNR Zone 2 shall have walls and roofs designed to provide a reduction of noise entering the structure from the outside that is equal to at least 25 dB, plus the amount by which the exterior CNR exceeds 100 dB.

(3) Specific noise reduction problems shall be considered when designing Unaccompanied Personnel Housing at Naval and Marine Corps Air Installations; however, all Unaccompanied Personnel Housing shall comply with the requirements in Table 1.

TABLE 1
Outdoor Noise Criteria

	Outdoor noise environment (L_{dn}/L_{eq} in dB)				
Facility	85-89	80-84	75-79	70-74	65-69
Unaccompanied personnel housing	No	No	NLR35*	NLR30*	NLR25*

*See next page for footnote.

*Although it is recognized that local conditions may require residential uses in these areas, this use is strongly discouraged in day-night average sound level/ equivalent sound level 70-74 and Ldn/Leq 75-79 and discouraged in Ldn/Leq 65-69. The absence of alternative development options should be determined. Noise Level Rating (NLR) criteria will not eliminate outdoor environment noise problems and, as a result, site planning and design should include measures to minimize this impact particularly where the noise is from ground level sources.

(4) Criteria for airborne and impact sound insulation shall be as given in Table 2.

TABLE 2
Airborne and Impact Sound Insulation

Floor ceiling assemblies between rooms	STC*	IIC*
Mechanical equipment room to bedroom	52 Min.	
Bedroom above bedroom	48 Min.	35 Min.
Wall partitions	STC	
Bedroom to bedroom	48 Min.	
Bathroom to bathroom	48 Min.	
Living room (lounge) to bedroom	50 Min.	
Mechanical space to bedroom	48 Min.	
Mechanical space to other areas	48 Min.	
Mechanical space to bathroom	48 Min.	
Bathroom to bedroom (adjoining suite)	52 Min.	
Bedroom to corridor	48 Min.	
Living room to corridor	48 Min.	

*STC - Sound Transmission Class, IIC - Impact Isolation Class.

d. Heights.

(1) In most cases, two or three stories are preferred for Unaccompanied Personnel Housing for ease of access in using stairs. Three stories shall be the maximum, unless limited real estate or other restrictions justify building heights in excess of three stories.

(2) Four-story walk-up designs will be permitted for large complements of persons where land area is restricted.

(3) Floor-to-floor heights shall be minimized to avoid excessive building volume. Floor-to-floor heights, however, should be derived in conjunction with careful evaluation of both mechanical systems and structural framing system economics.

(4) In Unaccompanied Personnel Housing, floor-to-floor heights shall not exceed 9 feet 6 inches. Where mechanical ventilation, natural ventilation, evaporative cooling, or air-conditioning is authorized, floor-to-floor heights may be increased as necessary to accommodate the mechanical system or natural ventilation requirements up to a maximum of 10 feet 6 inches. Minimum clear floor-to-ceiling heights shall be 8 feet except that a lower floor-to-ceiling height will be permitted in limited areas to accommodate mechanical equipment. Also consider clearance for wardrobes and other furnishings.

e. Floors.

(1) Floor finishes shall be durable, easily maintained, and aesthetically pleasing. Activity preferences should be considered in selecting floor finishes.

(2) Carpeting may be used in accordance with NAVFAC DM-1; Architecture and specific criteria in NAVFAC DM-36.2, DM-36.3, and DM-36.4.

f. Walls.

(1) Walls shall be designed for durability; imagination and variety shall be used to create interesting and livable spaces.

(2) The backing behind base materials on all stud partitions and walls shall be solid to prevent damage from floor buffers.

(3) In bathrooms and other wet areas a variety of wall materials may be used. However, they shall be moisture resistant and easily cleanable.

(4) Tack strips or other provisions should be considered in order to allow for installation of wall hangings or artwork without damage to finish surfaces.

(5) Bathroom wall construction shall consider access problems for eventual plumbing maintenance requirements.

g. Ceilings.

(1) Ceilings shall be economical and durable. Lay-in ceilings should be avoided.

(2) Where mechanical equipment, including adjustment and shutoff devices, is located above the ceiling, provisions must be made for access.

(3) Ceilings shall be maintainable and easily repaired in the event of damage.

h. Roof. Where feasible, roofs shall have a slope not less than 1/2 inch per foot. However, an absolute minimum of 1/4 inch per foot is required. A polyvinyl chloride (PVC) rain carrying system (gutters and downspouts) may be considered for use in climates where temperatures do not fall below 10 degrees F.

i. Built-In Equipment.

(1) Bookcases, reception desks or other fixed furniture shall be provided as built-in equipment only where appropriate and economical.

(2) Built-in equipment other than the above should be held to a minimum in order to allow for the flexible use of furniture.

(3) Predesign programming shall include liaison with the activity to determine whether mailboxes are required in Unaccompanied Personnel Housing and the degree of physical security required by the postal personnel for serving mailboxes. Tenant doors to mail compartments shall be provided with three-digit combination locks. Lock sequence shall be changeable at the option of activity management.

(4) Such details as bulletin boards, telephone enclosures, and similar features may be built-in for good appearance. Telephone area surround shall be of durable, grafitti-resistant surfaces that can be maintained easily.

j. Fire Protection.

(1) Design and construction shall conform to applicable provisions of the NFPA Codes and criteria contained in NAVFAC DM-8, Fire Protection Engineering.

(2) Exit facilities shall conform to applicable provisions of National Fire Protection Association (NFPA) Standard Code 101, Life Safety Code Chapter 11, and NAVFAC DM-8. Interior exit corridors shall have a 1-hour fire retardant rating with 3/4-hour C-rated self-closing fire doors at all openings. Dead end corridors shall not exceed 20 feet in length from the nearest exit. Finishes shall have a flame spread rating of 25 or less and smoke development rating of 50 or less.

(3) Firewalls shall be provided to limit floor areas for noncombustible construction as determined in NFPA Code requirements as they relate to building type, construction, configuration, and sprinkler applications.

(4) Enclosures for interior stairways, mechanical equipment rooms, and storage rooms shall have appropriate fire protection ratings in accordance with the NFPA Code occupancy requirements. Mechanical equipment rooms shall have outside entrances only.

(5) Carpet systems (carpet and underlay when tested together as they will be installed) shall have a flame spread rating of 75 or less when tested in accordance with ASTM E-84 (Surface Burning Characteristics of Materials Test), or a flame propagation index of less than 4.0 when tested in accordance with UL-992 (Chamber Method).

(6) A fire alarm system is mandatory for Unaccompanied Personnel Housing. Smoke detectors are also mandatory for life safety in accordance with (NFPA) Standard Code 101 and NAVFAC DM-8.

k. Fallout Shelters. Fallout shelters shall be provided where required and feasible for the authorized shelter scope (number of persons) and within the authorized funds. The shelter area must be for dual purposes, provide 10 square feet per person with a minimum size to accommodate not less than 50 persons, and be located within the facility. The shelter design shall be performed by a qualified fallout shelter analyst and be in accordance with NAVFACINST 3050.5B, Department of the Navy Fallout Shelter Program.

l. Handicapped. Accessibility for the physically handicapped is not required for Unaccompanied Personnel Housing.

Section 5. STRUCTURAL

1. GENERAL. The structural system shall be coordinated and integrated with the building system during the preliminary design phase. NAVFACINST 11012.133B, Seismic Investigation for Modernization Projects, Requirements for, provides general guidance for evaluation of existing structures scheduled for modernization. Economic analyses shall be performed in selecting structural systems.

a. Selection of Structural Systems. In selecting an appropriate structural system the following shall be considered.

(1) Suitability for permanent construction.

(2) Design loads capable of being carried and structural integrity.

(3) Compliance with fire protection requirements.

(4) Compliance with architectural and functional concepts as they relate to column and bay spacing, structural details as they impact the use and finish of interior spaces, and the aesthetic characteristics and design integrity of the facility.

(5) Materials to be economical for the area, and the design concept within the capability of local construction practices.

(6) Provision for low maintenance over the design life of the facility.

(7) To preclude moisture condensation in air-conditioned buildings in high humidity locations, special provisions and details for moisture control and protection shall be considered. Structural systems using steel joists with corrugated metal deck to support concrete slabs shall be avoided in high humidity areas or, where use is dictated by other considerations, proper measures must be taken to prevent moisture damage to steel components.

b. Soils Data and Foundations. Sufficient subsurface exploration shall be made at the outset to determine the suitability of the site in supporting the proposed structure in a sound, economical manner. Soil exploration may not be necessary for projects where design data regarding soil bearing and foundation conditions are already available and applicable. The foundations shall be designed considering soil conditions and topography.

c. Loads. Design loads shall conform to criteria contained in NAVFAC DM-2 Series, Structural Engineering.

d. Special Environmental Conditions. Care shall be taken in identifying all pertinent environmental factors such as snow and wind loads. Special conditions pertinent to typhoon, hurricane, and seismic forces must also be determined. Seismic loads and requirements shall conform to NAVFAC P-355, Seismic Design for Buildings. Design considerations shall allow for proper structural integrity in order that the building may act as a unit in transmitting lateral loads and uplift forces to the foundation. Considerations shall also be given to the effect of highly corrosive environments on structural materials used.

e. Structural Materials. In selecting appropriate materials, consideration shall be given to the following:

(1) Site, climate, subsurface conditions, accessibility, wind velocity, and seismic ratings.

(2) Skill and experience of prospective contractors.

(3) Design life of the facility and maintenance costs.

(4) Experience of design and inspection personnel.

(5) Availability of labor and materials.

(6) Feasibility of preassembly or precasting major components.

2. SITE ADAPTATION. The structural design of the building shall be coordinated with the specific site. This includes consideration of bearing capacities, topography, and accessibility for construction.

3. COST CONSIDERATIONS. Economic analyses shall be performed in order to determine the costs of various structural systems. The analyses should take into account such considerations as system cost, economic impact on other building systems, and the impact on function, including such factors as layout, efficiency of space, and volume relationships.

Section 6. HEATING, VENTILATING, AND AIR-CONDITIONING

1. GENERAL. Heating, ventilating and cooling (natural ventilation, mechanical ventilation, evaporative cooling, or air-conditioning) shall be provided as

applicable (see NAVFAC DM-3 series, and DOD 4270.1-M in addition to special requirements contained in NAVFAC DM-36.2, DM-36.3, and DM-36.4).

2. EXCEPTIONS TO CRITERIA. If natural ventilation or means other than air-conditioning are proposed for cooling a facility which is eligible for air-conditioning under DOD criteria, a written request for waiver shall be submitted to NAVFACENGCOM. Requests shall fully support and explain the requirement and shall include drawings sufficient to identify the total area of the facility, the area for which air-conditioning is authorized, the area for which a waiver is requested, and weather data including history of temperature and prevailing winds.

3. DESIGN CRITERIA.

a. Winter.

(1) Outdoor design temperature shall be selected from the 97-1/2 percent column of NAVFAC P-89, Engineering Weather Data.

(2) Indoor design temperature shall be 68 degrees F for occupied spaces and 40 degrees F for freeze protection in storage areas.

b. Summer.

(1) Outdoor design dry bulb temperature with coincident wet bulb shall be selected from the 2-1/2 percent column of NAVFAC P-89.

(2) Indoor design conditions shall be 78 degrees F and 60 percent relative humidity. Only the dry bulb temperature will be controlled.

4. HEATING AND COOLING LOAD CALCULATIONS. Use the procedures outlined in ASHRAE, American Society of Heating, Refrigeration and Air-Conditioning Engineers. See NAVFAC DM-36.2 and DM-36.3 for specific assumptions to be used for calculating loads for Unaccompanied Enlisted Quarters and Unaccompanied Officer Quarters.

5. PIPING SYSTEMS. General mechanical piping systems shall be designed in accordance with procedures outlined in ASHRAE. Piping systems from a base-wide central heating distribution system shall be in accordance with the latest issue of guide specifications for outside underground distribution systems. Reverse return piping systems are preferred over direct return systems. Flow control valves should be provided at all equipment. Flow control valves and special fittings permitting the attachment of portable flow measurement meters should be used on mains and main branches where balancing would be difficult.

6. DUCT SYSTEMS. Duct systems shall be designed in accordance with procedures outlined in ASHRAE. Supply and return duct systems shall be provided. Space above corridor ceilings may be used as return air plenums. Any nonmetallic ductwork shall comply with fire and smoke rating requirements. Reference shall be made to (NFPA) Standard Code 90A and NAVFAC DM-8 for special requirements on smoke control.

7. EVAPORATIVE COOLING. This paragraph applies to Zone A only (see DOD 4270.1-M). Single stage evaporative cooling systems shall have a minimum efficiency of 80 percent. Two-stage evaporative cooling systems shall have a minimum of 15 degrees F approach to wet bulb on the first stage and a minimum overall efficiency of 90 percent. Wall openings shall be provided with weather louvers and tight closing dampers. A separate air handling unit shall be provided with the evaporative cooling system to provide a minimum ventilation during winter months. Shutoff dampers shall be provided to isolate this unit during the cooling season.

8. MECHANICAL VENTILATION. This paragraph applies to Zone C only (see DOD 4270.1-M). Mechanical ventilation systems shall provide not less than a 5-minute air change nor more than a 2-minute air change.

9. DESIGN RECOMMENDATIONS.

a. Air-cooled Condensing Units. Condensing temperature shall not exceed 135 degrees F at outside design conditions. Entering air to condensing temperature differential shall not exceed 30 degrees F. Condensing temperature should be selected at the lowest point within design and first cost considerations in order to reduce compressor horsepower and energy consumption.

b. Ducted Systems. Where ducted systems are used, selection of duct ratios should not exceed 4 to 1.

c. Central Air Handling Units. Where central air handling units (ducted systems) are used, consider low coil face velocities to reduce static pressure and energy consumption.

10. CONTROLS.

a. Ducted Central Air Systems. For ducted central air systems, except variable air volume, temperature control shall be by zones. The building should be zoned by floors and orientation. Thermostats shall be the tamper-proof type. Variable air volume (VAV) system temperature control may be by individual rooms served with VAV terminal units.

b. Outdoor Reset Control. Outdoor reset control shall be provided for hot water heating systems. The outdoor control shall shut off the heating systems when outdoor temperature exceeds 65 degrees F. Separate reset control shall be provided for zone pumps serving different orientations. End rooms of a building wing shall not be considered a separate zone.

c. Individual Room Units. Where heating or cooling is provided by an individual room unit, such as a fan-coil unit or VAV terminal unit, an individual room control shall be provided.

d. Thermostats. Thermostats must be provided with factory-set, nonadjustable upper limits for heating cycle control and lower limits for cooling cycle control. Refer to DOD 4270.1-M for detail requirements. Thermostats shall be adjustable within the rigidly fixed limits of DOD 4270.1-M.

e. Electric Heating. All electric heating units shall be thermostatically controlled. Refer to NAVFACINST 4100.4A, Electric Resistance Space and Domestic Water Heating, limited use of, for limitations on the use of electric heat. Timers shall be provided for bathroom heaters.

11. DESIGN LIMITATIONS. The use of electric resistance type space heating and domestic water heating is expressly limited to the criteria provisions set forth in NAVFACINST 4100.4A.

12. QUALITY OF MATERIALS. Material, equipment, installation, and quality shall conform to the criteria listed under the specific systems in Table 3.

TABLE 3
Applicable Specifications Pertaining to Quality of Materials

System	Guide specifications
Heating, ventilating, and air-conditioning	NAVFAC TS-15011 - General Requirements, Mechanical TS-15180 - Insulation of Mechanical Systems TS-15652 - Central Refrigeration Equipment for Air-Conditioning TS-15653 - Unitary Air-Conditioning Systems TS-15711 - Hot Water Heating System TS-15721 - Steam System and Terminal Units TS-15802 - Air Supply Systems Black Steel Pipe A53, with insulation, vapor barrier and weatherproof aluminum jacket in accordance with NAVFAC TS-15180.
Testing	NAVFAC TS-15907 - Testing and Balancing Air and Water Systems

TABLE 3 (continued)
Applicable Specifications Pertaining to Quality of Materials

System	Guide Specification
Outside distribution lines	
(1) Heating (above 250 degrees F)	NAVFAC TS-15P28 - Heat-Distribution Systems Outside of Buildings
(2) Chilled water (above ground and below ground)	Black Steel Pipe ASTM A53, insulation shall be cellular glass or approved equal barrier and protection shall be cut-back asphalt cloth, fibrous wrap, cut-back asphalt and pipeline felt or approved equal.
(3) Dual temperature (250 degrees F and below)	

Section 7. PLUMBING

1. GENERAL. Plumbing fixtures and circulation systems shall be carefully designed to insure economy of layout and ease of maintenance. Quality systems shall be used in order to ensure performance throughout the design life of the facility.

2. CENTRAL EQUIPMENT AND DISTRIBUTION SYSTEMS.

a. Domestic Water Heaters. Domestic water storage heaters shall be sized in accordance with Figure 1 and shall be furnished and installed by the contractor.

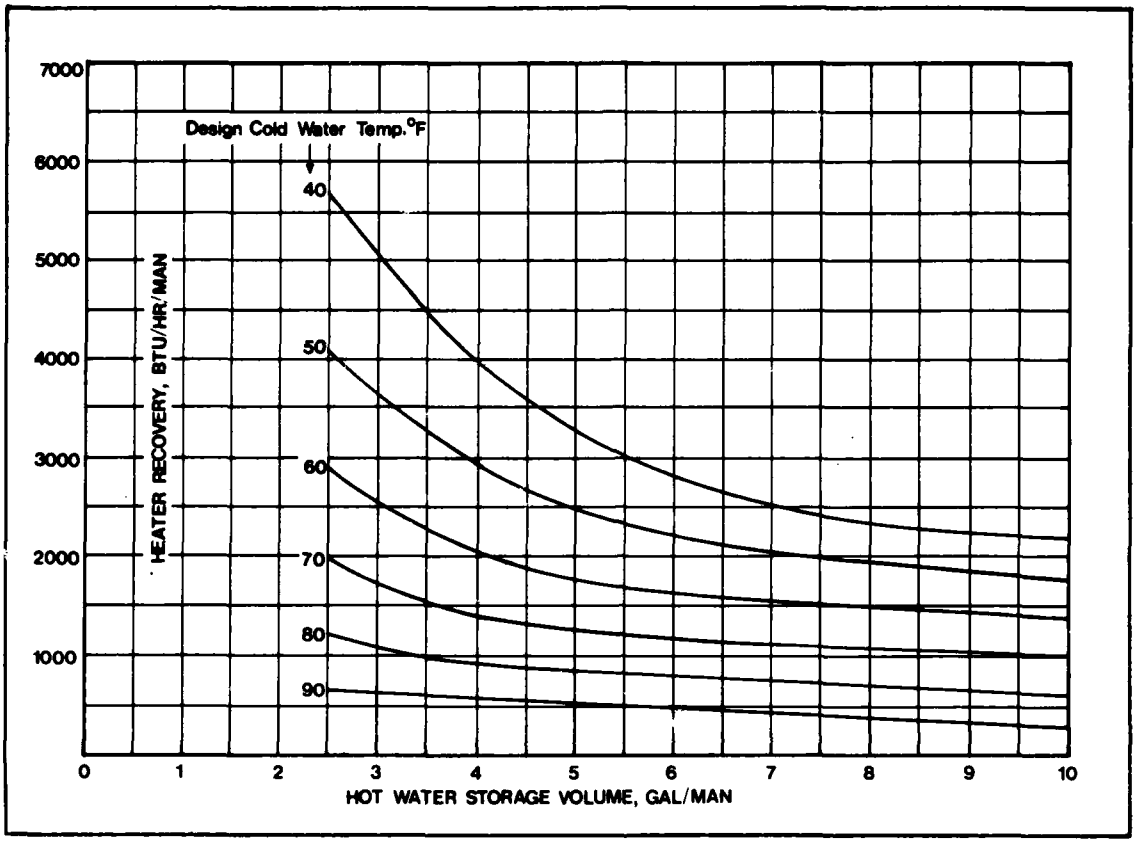

FIGURE 1

Heat Recovery Versus Hot Water Storage Volume
For Various Design Cold Water Temperatures

b. Solar Energy. Consideration should be given to solar energy as a primary or a supplemental heating hot water source. Where solar energy is considered for use, water storage capacity will be based on system life-cycle economics.

c. Domestic Hot Water Temperatures. The following guidelines for temperature of domestic hot water shall be followed.

(1) Actual measured temperature delivered to the user will not exceed 100 degrees F in:

(a) All latrines, heads, and toilet facilities without showers or tubs;

(b) Buildings with only a few showers, or showers having a low frequency of use; for example, the duty officer room.

(2) Actual measured temperature delivered to the user will not exceed 110 degrees F in:

(a) All latrines, heads, and toilet facilities with showers or tubs;

(b) In buildings, such as Unaccompanied Officer Quarters and Unaccompanied Enlisted Quarters, where there is both heavy and frequent use of the bathing facilities and there is a common hot water supply system for toilet facilities with and without showers or tubs. Where laundry facilities exist, occupants should be advised to use "cold water" type detergents if washing difficulties are encountered.

(3) In buildings operated on a nominal 40-hour week, or in buildings operated on a nominal two-shift basis (either 5- or 7-day week), a clock or other automatic control shall be installed on the domestic hot water circulating pump or pumps to permit operation only during periods of actual occupancy plus 30 minutes before and 30 minutes after normal working hours.

(4) It is recognized that in some older buildings, or in some unusual cases, it may be necessary to do more than reset existing temperature controls. In some cases, added storage tanks, temperature blending equipment, or separate lines might be required. Where the aggregate of this work on any one installation meets the minimum requirements for the Energy Conservation Investment Program (ECIP), consideration should be given to including the work under this program provided the ECIP amortization guidelines can be met.

(5) It is not intended that there be any modification of the temperature of hot water used for dishwashing in dining halls and other food service areas.

d. Distribution Systems.

(1) Outside hydrants shall be provided at approximately 150-foot intervals.

(2) Circulation of domestic hot water shall be provided when any portion of the system extends horizontally more than 100 feet from the water heater. Circulation shall be limited to horizontal mains. The piping through which circulation is provided (supply and returns) shall be insulated.

(3) Water hammer arresters shall be provided in water supplies where quick-closing valves are installed, such as at washing machines and dishwashers.

(4) Water closet and shower drains shall not be individually vented unless it is done within the allowance of the National Plumbing Code.

(5) Pipe chases shall be of adequate size for accessibility.

(6) Showers shall be equippped with flow control devices to limit water flow to 3 gallons per minute (gpm).

e. Quality of Materials. Plumbing materials, equipment, and installation except outside distribution lines, shall conform to the following criteria:

(1) All equipment, materials, and fixtures shall conform to NAVFAC Guide Specification TS-15401, Plumbing. Where insulation of piping and equipment is required, TS-15180, Insulation of Mechanical Systems, shall be used.

(2) Outside domestic hot water lines shall be insulated and protected as hereinbefore specified by TS-15180 for chilled water lines.

Section 8. ELECTRICAL

1. GENERAL

a. Underground Service. Provide underground service where possible.

b. Emergency Generators. Operation and location of specific facilities should be reviewed to determine if a requirement exists for fixed emergency generators or connections for portable emergency generators.

c. Emergency Lighting. Emergency lighting systems shall be provided in accordance with (NFPA) Standard Code 101, Life Safety Code.

d. Smoke Detectors. Smoke detectors shall be provided in accordance with NFPA 101, Life Safety Code.

e. Lighting. See NAVFAC DM-4, Electrical Engineering, for lighting criteria.

f. Fire Alarms. Fire alarm systems shall be provided. The systems shall be supervised, closed-circuit, and connected to the fire department system and conform to (NFPA) Standard Code 72.

g. Telephones. Provide telephone service entrance, cabinet, and outlets.

h. Ground Fault Protection. Use ground fault circuit interrupter (GFCI) receptacles instead of ground fault circuit breakers to provide ground fault protection in accordance with the National Electrical Code (NEC). Install the receptacles so each room occupant has easy access to his corresponding GFCI receptacle reset button.

i. Detailed Design Criteria. For more detailed design criteria, see NAVFAC DM-4 Series.

Section 9. INTERIOR DESIGN

1. GENERAL. NAVFACINST 11012.120, Interior Design, provides interior design guidance. Interior design guide systems are available for use with Navy and Marine Corps multiuse designs and include a selection of furniture styles and

color schemes. Where such guidance is not used, imagination and the creative use of colors and furnishings shall be provided. Design solutions shall also be economical and the furnishings maintainable.

2. FURNITURE AND FURNISHINGS. Loose furniture and furnishings shall be provided as collateral equipment and are not a part of the construction contract.

a. Window Coverings. Horizontal venetian blinds or traverse draperies shall be provided for all windows. Venetian blinds and traverse drapes are not to be used together. Care should be taken to coordinate construction details to allow for installation of window coverings. The window details and type should also be considered in order to allow for ease of operation.

b. Artwork. Interior design considerations should include the appropriate use of artwork to complement the building.

c. Signage. All required directional identification and regulatory signage, coordinated with other elements of the interior design, shall be included in the plans and specifications. The sign system shall be commercially available, nonproprietary signage appropriate to the project.

d. Carpet. Carpet shall conform to TS-09682, Carpet. Carpet tile (dining facilities only) shall conform to TS-09690, Carpet Tile.

3. COLORS AND COLOR COORDINATION. Colors shall be selected to create an interesting, imaginative decor for increased livability and provide a coordinated scheme, durability, maintainability, and coordination with furnishings.

4. LIGHTING AND FINISH COORDINATION. Lighting shall be used where appropriate to provide accent and highlight decorative finishes. Special decorative lighting may be used in the entrance lobby or other appropriate community spaces.

APPENDIX A

Metric Equivalence Chart

Conversions are approximate		
5 Foot Line	=	1 525 mm
7 Feet	=	2 125 mm
22 Inches	=	559 mm
5 Square Feet	=	0.46 m^2
4 Feet	=	1 225 mm
18 Inches	=	450 mm
15 Degrees F	=	-9 Degrees C
65 Degrees F	=	18 Degrees C
9 Feet 6 Inches	=	2 900 mm
10 Feet 6 Inches	=	3 200 mm
8 Feet	=	2 450 mm
1/2 Inch Per Foot	=	13 mm per 3 050 mm
1/4 Inch Per Foot	=	6.5 mm per 3 050 mm
20 Feet	=	6 100 mm
25 Feet or Less	=	7 600 mm
50 Feet or Less	=	15 200 mm
75 Feet or Less	=	22 900 mm
10 Square Feet	=	0.93 m^2
68 Degrees F	=	20 Degrees C
40 Degrees F	=	4 Degrees C
78 Degres F	=	26 Degrees C
15 Degrees F	=	-9 Degrees C
135 Degrees F	=	57 Degrees C
30 Degrees F	=	-1 Degree C
65 Degrees	=	18 Degrees C
250 Degrees F	=	121 Degrees C
100 Degrees F	=	38 Degrees C
110 Degrees F	=	43 Degrees C
150 Feet	=	45 700 mm
100 Feet	=	30 500 mm
3 Gallons	=	11 l

REFERENCES

National Electrical Code, (NEC), National Fire Protection Association, Boston, MA 02210.

National Plumbing Code, American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

ASHRAE, American Society of Heating, Refrigeration, and Air-Conditioning Engineers, available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 345 East 47th Street, New York, NY 10017.

National Fire Protection Association, (NFPA) Standard Code 101, (NFPA) Standard Code 90A, and 72, National Fire Protection Association, Boston, MA 02210.

Glazed Panels, Safety Standard for Architectural Glazing Materials, (16CFR Part 1201), July 6, 1977, U.S. Consumer Product Safety Commission, Washington, D.C. 20207.

NAVFACENGCOM Design Manuals, P-Publications and Instructions

DM-1	Architecture
DM-2 Series	Structural Engineering
DM-3 Series	Mechanical Engineering
DM-4 Series	Electrical Engineering
DM-5 Series	Civil Engineering
DM-8	Fire Protection Engineering
DM-36.2	Unaccompanied Enlisted Quarters
DM-36.3	Unaccompanied Officer Quarters and Dining Facilities
DM-36.4	Enlisted Personnel Dining Facilities
P-68	Contracting Manual
P-80	Facility Planning Criteria
P-89	Engineering Weather Data
P-272	Definitive Designs for Naval Shore Facilities
P-309	Color for Naval Shore Facilities
P-355	Seismic Design for Buildings
P-904	Planting Design
3050.5B	Department of the Navy Fallout Shelter Program
4100.4A	Electric Resistance Space and Domestic Water Heating; limited use of
4100.5A	Design Criteria Guidance for Energy Conservation
4100.7	Energy Conservation in New and Rehabilitated Buildings by Computer Simulation of Building Energy Consuming Systems
11012.120	Interior Design
11012.133B	Seismic Investigation for Modernization Projects; Requirements for

Government agencies may obtain Design Manuals and P-Publications from the U.S. Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120. TWX: 710-670-1685, AUTOVON: 442-3321. The stock number is necessary for ordering these documents and should be requested from the NAVFACENGCOM Engineering Field Division in your area.

Non-Government organizations may obtain Design Manuals and P-Publications from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

NAVFACENGCOM Type Specifications

TS-09682	Carpet 043
TS-09690	Carpet Tile
TS-15011	General Requirements, Mechanical
TS-15180	Insulation of Mechanical Systems
TS-15401	Central Plumbing
TS-15652	Central Refrigeration Equipment for Air-Conditioning
TS-15653	Central Unitary Air-Conditioning Systems
TS-15711	Hot Water Heating System
TS-15721	Steam System and Terminal Units
TS-15802	Air Supply Systems
TS-15907	Testing and Balancing Air and Water Systems
TS-15P28	Outside Heat Distribution Systems

Type Specifications are available, free of charge, from the U.S. Naval Publications and Forms Center, Philadelphia, PA 19120.

Department of Defense (DOD) Publications

4270.1CG	DOD Military Construction Cost Review Guide
4270.1-M	DOD Construction Criteria Manual

Non-Government organizations may obtain DOD Publications from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Identification of Retrofit Projects for Buildings, DOE/CS-0133, available from the U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

Impact Noise Control in Multifamily Dwellings, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Chamber Method, UL-992, available from Underwriters Laboratories Inc., Northbrook, IL 60062.

Black Steel Pipe, ASTM A53, available from the American Society for Testing and Materials, Philadelphia, PA 19103.

Surface Burning Characteristics of Materials Test, ASTME-84, available from the American Society for Testing and Materials, Philadelphia, PA 19103.

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